

**FEED RESOURCES AND THEIR RELEVANCE IN FEEDING  
SYSTEMS IN DEVELOPING COUNTRIES**

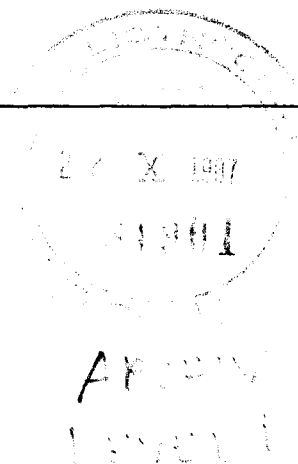
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## **FEED RESOURCES AND THEIR RELEVANCE IN FEEDING SYSTEMS FOR GOATS IN DEVELOPING COUNTRIES**

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**ABSTRACT.** Constraints to more effective use of the feed resources and their relevance in feeding systems are discussed in relation to solutions and nutritional strategies that can increase productivity in goats. Increasing this productivity needs to take advantage of inherent attributes in the species and use of the available dietary ingredients including non-traditional feeds, in efficient feeding systems that can match predictable responses (meat, milk, fibre and skins). An essential prerequisite for high performance in maximum voluntary feed. With coarse crop residues, physical, chemical or biological pretreatments may be necessary to alleviate fibre digestion; of these chemical treatment with urea-NH<sub>3</sub> treatment appears promising. Supplementation with energy, protein and minerals is an important means to correct nutrient limitations of which dietary proteins are especially important. The latter can be enhanced by the economic use of preformed protein sources, non-protein nitrogen sources (NPN), urea-molasses block licks and with leguminous forages. The nutritional strategies that are potentially important to sustain all year round feeding (dry and wet seasons) include wider and more intensive use of crop residues and agro-industrial by-products, expanded forage production on available land, increased use of dietary nitrogen sources and strategic use of supplements. These and other strategies represent important initiatives in the search for efficiency concerning the use of both the feed and goat genetic resources for food production in the developing countries.

### **INTRODUCTION**

In animal production systems a particular species is often developed because of its ability to make use of available feedstuffs. This is particularly true of the goat with its wide distribution and adaptation throughout the world. As a ruminant it utilises cellulose and through the participation of the rumen flora, converts non-protein nitrogenous materials to valuable animal proteins. Perhaps the greatest advantage of the animal is its ability to subsist and utilise native vegetation and coarse feeds in land areas such as the arid and semi-arid regions which are useless for cultivation to produce foods which are in very high demand. This is reflected for example in the Black Bedouin goats in the Sinai desert, which despite the very dry environment, is fully adapted and use the sparse feeds available to produce daily

about 2kg of milk (Shkolnik, Maltz and Gordin, 1980). Indeed, the very wide distribution of the goat populations, ability to thrive in harsh environments and utilise the feeds often of poor quality suggests that their value as animal resources to produce foods of value to mankind can be explored more fully. In this context, the value of the species increases with decreasing quality of the available feeds, implying that in terms of utilisation of fibrous lignocellulosic feeds and residues, goats are presently playing a valuable role in food production.

Two principal constraints concerning the utilisation of the feed resources in most parts of the developing countries are availability and efficiency. The problem involves all types of production systems and all regions. The situation is exacerbated by several interrelated factors and include inter alia inadequate feed supplies, underutilisation, periods of feed scarcity and inadequate innovative feeding systems that can apply available knowledge and stimulate increased performance. This has in turn contributed to the prevailing situation where the per caput supplies of goat meat, the most important product in the developing countries, to decline over the last two decades (Devendra, 1987). The declining supply of meat and a widening gap between production and consumption is likely to continue in the face of increasing human population growth and inability of the goat population to respond to the demand for increased supplies of food.

In view of this situation, it is particularly important to consider in some detail the types of feeds available, the extent of this availability and their relevance in feeding system. The primary question is whether the available feed resources are adequate, and if this is the case, if these feeds are being efficiently utilised for conversion to useful products (meat, milk, fibre and skins). Even more pertinent, it is relevant to consider the value of new strategies appropriate to the developing countries which can enhance performance and production from goats.

This Symposia will have six other paper presentations. The first of these will deal with the utilisation of grasses, the next four will deal with the utilisation of feed resources in different regions, and the last will address the use of mineral supplements specific to goats. These papers together will provide a comprehensive global coverage. The present paper will aim to complement these presentations by considering basic issues involved with the utilisation of the feed resources and more particularly, the application of nutritional strategies that are likely to increase productivity from goats in the developing countries.

## BASIC CONSIDERATIONS

In order to ensure that goats are able to achieve high performance which is consistent with their genetic potential, it is essential that they are supplied with adequate nutrients (energy, proteins, vitamins and minerals) which can match predictable responses in the animal body in regard to products (meat, milk, fibre or skins). In seeking to achieve this balanced nutrient supply, it is realistic in seeking efficiency in feeding systems for a specific situation to take advantage of the available dietary ingredients and aim for a realistic, potential and economic level of production.

An essential prerequisite for good performance is maximum voluntary feed intake (VFI). The net energy absorbed each day is controlled by three different but related parameters (Minson, 1985), and are the quantity of food eaten(I), the proportion of each unit of feed that is digested(D), and the efficiency of the products of digestion(E). This is represented by the equation  $NE = I \times D \times E$ .

The degree of lignification in the fibre represents the main barrier to intake and digestion even if protein, minerals and vitamins are adequate. In order to overcome this, physical, chemical and biological treatments have been attempted with crop residues, of which chemical treatment especially with urea-NH<sub>3</sub> treatments appears to be particularly promising.

Of the limiting nutrients, protein is the most critical. Dietary protein is of three categories : (1) rumen degradable protein (RD) which is used for microbial protein synthesis, (ii) undegraded dietary protein (UDP) which escapes digestion in the rumen and is absorbed in the small intestines, and and (iii) undigested UDP which escapes fermentation and absorption in the intestines. The RDP requirements are considered to be 30 g N/kg of organic matter apparently digested in the reticulo-rumen (A.R.C., 1980). It has been estimated (Leibholz and Kellaway, 1984) that the minimum required crude protein of a poor quality diet with a digestibility of organic matter of 50% would be between 6.1 - 7.4%. With most crop residues with low nitrogen content, and especially cereal straws with 4% crude protein, protein supplementation is clearly necessary.

## THE FEED RESOURCES

The categories and extent of availability of the feed resources determines the level of production. Where these are inadequate such as in many countries in the Near East and North Africa, remedial measures are required that can make good the shortfalls and sustain production. Given the climatic limiting factors that do not allow for substantial expansion in the feed supply base, alternative feeding

strategies need to be developed that can alleviate poor performance. Conversely, in many parts of the humid tropics, feed availability is in excess of animal requirements which suggests that considerable expansion in ruminant production is feasible.

The problem is particularly acute in Asia where the feed requirements by livestock are in excess of current supplies. Recent analyses of the feed resource base in Asia in terms of the area under pasture and fodder crops, quantities of available feed grains, oil cakes and agricultural by-products, suggest a quantitative and qualitative insufficiency of feeds in relation to the total requirements for growth, reproduction and production of the livestock sector (Verma, 1983).

In the Indian sub-continent, it has been estimated that there is an annual shortage of 8.5 million tonnes of concentrates (44%), 38.4 million tonnes of dry fodder (11%) and 129.4 million tonnes of green fodder (38.4%) for dairy animals (National Commission on Agriculture, 1976). Likewise in Pakistan, despite the availability of  $14.2 \times 10^6$  tonnes of total digestible nutrients (TDN) and  $1.4 \times 10^6$  tonnes of crude protein, there causes a deficit of 49% energy and 42% digestible crude protein (DCP). Similarly, feed shortfalls also exist in Bangladesh (Dickey and Huque, 1985) and Thailand (Khajjarern and Khajjarern, 1985). By comparison, in more humid countries, such as in Malaysia (Devendra, 1982a) or Sri Lanka (Ranjhan and Chadhokar, 1984), the feed resources are in excess of the requirements of farm animals. A component of the feed resources that is underutilised and merits more attention for feeding to goats concerns non-conventional feed resources (NCFR). Table I summarises the total availability from field and plantation crops in Asia and the Pacific alone.

The generation of NCFR is very much higher than these figures suggest as the calculated availability do not include production from a variety of other field crops, statistics for which are not available in the data. Additionally, there are also residues and wastes from animal sources and the processing of food for human consumption and an abundant variety of tree fodders which have also not been included. Likewise, there probably also exist substantial categories of NCFR in the other tropical regions such as the Near East, Africa and Latin America.

Non-conventional feedstuffs have a number of characteristics that are peculiar to them (Devendra, 1985). These are as follows :

- (i) They are the end products of production and consumption that have not been used, recycled or salvaged.
- (ii) They are mainly organic and can be in a solid, slurry or liquid form.

- (iii) Their economic value is often less than the cost of their collection and transformation for use, and consequently they are discharged as wastes.
- (iv) The feed crops which generate valuable NCFR are excellent sources of fermentable carbohydrates eg. cassava and sweet potato and this is an advantage to ruminants because of their ability to utilise inorganic nitrogen.
- (v) Fruit wastes such as banana rejects and pineapple pulp by comparison have sugars which are energetically very beneficial.
- (vi) Concerning the feeds of crop origin, the majority are bulky poor-quality cellulosic roughages with high crude fibre and low nitrogen contents, suitable for feeding to ruminants.
- (vii) Some of the feeds have deleterious effects on animals, and not enough is known about the nature of the active principles and ways of alleviating the effects.
- (viii) They have considerable potential as feed materials, and for some, their value can be increased if there were economically justifiable technological means for converting them into some usable products.
- (ix) More information is required on chemical composition, nutritive value, toxic factors and value in feeding systems.

In this context, it has been estimated that in Asia and the Pacific, NCFR account for approximately  $194.1 \times 10^6$  tonnes which is about 45% of the total availability from field and plantation crops. Approximately 80% of the NCFR is from field crops and 93% of the feeds in tree crop cultivation (table I) are principally suited for feeding ruminants, including goats.

In more extensive systems, browse is important in the diets of goats, as is the case in Africa and Latin America. In Northern Africa, browse forms 60-70% of rangeland production and 40% of the total availability of animal feeds in the region. Present evidence suggests that in extensive systems, browse constitutes up to 85% in the diet of goats compared to about 30% in sheep (Devendra, 1986a).

It has been estimated by Fitzhugh et al. (1978) that the feed energy requirements of ruminants in industrialised and less-industrialised regions are less than the feed energy resources available, suggesting that there exist considerable scope to utilise existing reserves to increase production.

The problem however, may well be one of distribution in that often feed surpluses in one country or region are location specific. Such situations exist in the arid and semi-arid regions where feed deficits are chronically endemic.

Table 2 attempts to quantify the total daily feed energy and crude protein requirements by region using the FAO (1984) population data for goats. The requirements for energy have been calculated on the assumption of a mean adult weights of 30 kg for goats (only for meat) in the tropics and 40 kg for goats (mainly for milk) in the temperate regions. The corresponding daily energy requirements were 6.78 MJ/animal and 18.74 MJ/animal and 105 g/animal and 363 g/animal (N.R.C., 1981). The requirements are quite considerable and consistent with the high goat populations in Africa and Asia.

### SUPPLEMENTATION

Although energy, protein, minerals and vitamins are used as supplements, proteins are by far the most important. Urea, which is the most popular chemical used for upgrading the quality of rice straw, does not achieve much more than improve the quality of the feed to support maintenance needs. This means that in order to provide the necessary requirements for production, supplementation with specific requirements are essential. The inadequacies need to be corrected to provide additional requirements, and is an important means to alleviate nutrient limitations.

The requirements of supplements is justified by three particular situations :

- 1) Drought feeding where there is a total scarcity of feeds either periodically or long term. This is a common occurrence in many parts of the Near East and Africa.
- 2) Low level of nutrition due to a combination of under-nutrition, poor nutrition, management variables, nutrient requirements and genetically inferior animals. This situation is a common feature throughout the developing countries. With goats, the importance of good nutrition is seen in the lactation performance of two breeds Barbari (meat and milk) and Jamnapari (milk) in India, the total milk yields being improved by mean values of between 226-315% compared to a lowplane of nutrition over five consecutive lactations. A significant finding was that in both breeds low nutrition tended to affect milk yields in the fourth and fifth lactations (Sachdeva *et al.*, 1973). Likewise, improved nutrition increased meat production in Katjang goats, with live weight at slaughter, hot carcass weight, dressing percentage and weight of meat being improved by as much as 53.8, 79.3, 7.1 and 47.1% respectively (Devendra, 1979) compared to animals from rural areas.

3) High producing lactating animals with high dairy merit whose requirements for supplements and good management are maximum.

The justification for concentrate supplementation, (mainly energy and protein), is associated with four factors:

- (a) Scarcity of nutrients for milk production quantitatively and qualitatively.
- (b) Restriction in energy uptake imposed by bulky roughages.
- (c) Relatively low price of alternative mixed feeds, home grown or purchased concentrates.
- (d) Increased yield (meat or milk) of a monetary value greater than the cost of the feed required to produce it.

**(i) With Preformed Protein Sources**

There exist several types of preformed protein supplements that can be used. These include traditional sources such as coconut cake, soyabean meal, fish meal or rice bran and less well known sources which are essentially non-conventional. With coconut cake and rice bran for example, there has been a clear demonstration of response in terms of increasing live weight gain and feed efficiency in native Philippines goats when these constituted 84% of the concentrate diets (Linggordjiwo, 1976). Likewise, there are several other examples of proteins that can also be used for this purpose. Table 3 summarises several common examples.

**(ii) With Non-Protein Nitrogen (NPN)**

Urea, usually with molasses supplementation has been traditionally used widely for sheep and cattle, but less so with goats. This has been shown to reduce weight loss in cattle and in sheep (Coombe, 1959). In Philippines, 1% urea (3% of urea-molasses mixture) in the concentrate diet significantly improved average daily gain and feed efficiency (Table 4). In Nigeria, N balance and growth studies with West African dwarf goats have shown that urea was better than groundnut cake (Mba, Akinsoyinu and Olubajo, 1974).

Biuret is another NPN source which can be used and is a slow release nitrogen supplement. Poultry litter has uric acid which is also slowly degraded in the rumen, whereby the ammonia released can be more efficiently utilised. It has been shown to have beneficial effects in Thailand and Pakistan (Tinnimit, 1977; Hasnain, 1983). Efficient use of the ammonia released in the rumen necessitates however, the presence of readily available energy (eg. cassava chips) and also sulphur.

**(iii) With Urea-molasses Block Licks**

Recently, gelled urea-molasses blocks licks (UMBL) have been used to facilitate the availability of urea, minerals and possibly even drugs to support maximum use of least cost basal diets. The nature of these blocks and their advantages have been described (Leng and Preston, 1983; Mahadevan, 1983).



Urea-molasses blocks have been fed to milking buffaloes where up to 60% reduction in concentrate requirements have been observed (Leng and Preston, 1983).

(iv) **With Forages**

Supplementing with, and more intensive use of forages in feeding systems, represents an alternative means of increasing the utilisation of especially dry roughages. There are several attendant advantages and include :

- (1) Easy accessibility on the farm.
- (2) Abundant variety especially in the humid tropics.
- (3) Many are valuable sources of protein minerals and vitamins.
- (4) With some like leucaena (Leucaena leucocephala) a protein source is ensured even during the dry season.
- (5) Provide variety in the diet.
- (6) Have a stimulating effect on intake, and
- (7) A laxative influence on the alimentary system.

While there are several examples of forages including a variety of grasses, some of the more important proteinaceous forages include acacia (Acacia spp.), banana (Musa spp.), cassava (Manihot esculenta Crantz), pigeon pea (Cajanus cajan), gliricidia (Gliricidia maculata), sesbania (Sesbania grandiflora) and water hyacinth (Eichornia crassipes). In integrated farming systems, the use of these supplements is clearly of advantage (Devendra, 1983a).

Examples of their use with goats are not extensive, but include cassava leaves with goats in Indonesia (Winugroho and Chaniago, 1983; Soedomo-Reksohjadiprodjo, 1984) and sheep in Malaysia (Devendra, 1983b) and leucaena leaves in the Philippines (Rasjid and Perez, 1980) goats and sheep in Malaysia (Devendra, 1982b; Devendra, 1983b).

Forage quality is important in ensuring a high intake of it as well as the base roughage. In some cases supplements of leucaena to rice straw for example, had little effect on digestibility even when they comprised a significant proportion of the diet (Morgan, 1983), whereas with the others there was a significant increase in metabolisable energy (ME) intake and nitrogen retention (Devendra 1983b). Table 5 summarises the results.

The implication of these findings is that if higher dietary energy and nitrogen are to be made available to animals, then a more leafy forage (with less twigs and stems) needs to be provided. In this context Veerasilp (1981) demonstrated that when high quality leaf meal or gliricidia leaf was included at between 10-12% of dietary dry matter of a rice straw-based diet, live weight losses were small over a 45 day period.

In terms of practical application, (Ranjhan, 1983) recommended that feeding straws with green fodders, whether these are grasses or legume in the ratios of 3:1 or 1:1 should meet the requirements for maintenance and growth respectively. On the other hand, it has been suggested that green forages, preferably legumes, can be given up to a maximum of about 0.7% (dry matter basis) of live weight or about 25% of the diet (Preston and Leng, 1984). Palatability of the forage is important and as far as is possible, there should also be minimum toxic components in the feed that limit their utilisation.

It is of interest to note that comparisons between supplementation of straw-based diets with green forages versus urea pretreatment of the straw for growing cattle (Cheva-Isarakul and Potikanond, 1985) and lactating cattle (Promma et al., 1985) have given similar production responses, emphasising the value of judicious combination of available feeds. The appropriateness of the right option needs to be considered carefully in relation to the prevailing circumstances.

#### **(v) Economic Aspects Of Supplementation**

The final value of any pretreatment technique is the economic advantage to be derived and this aspect has been emphasised (Giaever, 1984; Greenhalgh, 1984). The total costs of the pretreatments need to be weighed against the beneficial effects, including the extent of the animal response. To be economic, maximum advantage should be sought from the effects of treatments. However, most research reports have not addressed this issue in feeding trials with or without supplementation in terms of response in goats.

### **NUTRITIONAL STRATEGIES**

There are a number of nutritional strategies that can be extended to enhance goat production. These have recently been discussed (Devendra, 1986b), but are reiterated with specific reference to the feed resources. The focus on nutritional strategies is also justified by the fact that in many cases, existing production systems are unlikely to change in the foreseeable future.

#### **(1) Increased Utilisation of Crop Residues and Agro-Industrial By-Products**

More intensive use needs to be made of large amounts of lignocellulosic materials and other agro-industrial by-products, simply because these are the cheapest and most widely available feeds for ruminants. This conclusion has also been previously emphasised (F.A.O., 1982; Mahadevan, 1982). For successful application, acceptable feeding systems are those that are simple, practical, within the limits of farmers' capacity and resources availability,

convincing and consistently reproduceable. Moderate to low levels of animal performance may be biologically inefficient, but could be more economically viable than high levels of performance especially with existing limitations of small farm systems and access to production resources.

Not enough use is being made of the various crop residues, agro-industrial by-product feeds to feed both goats. This is possibly due to inadequate use of intensive feeding systems such as that which has been successfully demonstrated for sugarcane by-products fed to goats in Fiji (Hussein et al., 1983), cereal straws in India (Sehgal and Punj, 1983) or Cyprus (Hadjipanayiotou, 1984).

## **(2) Increased Forage Cultivation on Available Land**

Where possible, there needs to be increased cultivation of forages, grasses and legumes on available land. This can be undertaken in any waste or uncultivated land, rice bunds and fence lines. The use of leguminous forages like leucaena (*L. leucocephala*) or sesbania (*S. grandiflora*) is underestimated and very much more use can be made of these especially as supplements (Devendra, 1984). The former is the most widely used forage for feeding ruminants in South East Asia (Devendra, 1986c) and provides an excellent source of fodder and dietary nitrogen even during droughts and can be used as a good fence line. The presence of such forage reserves form an important component of integrated agriculture in small farms and go a long way towards furnishing much needed nutrients to enhance prevailing low levels of animal performance in the developing countries.

The basic strategy is to produce and use sufficient amounts of feed of good quality that are available all the year round including dry and wet seasons (Devendra, 1986d). On small farms, the demand for food crops supercedes production of feeds for livestock. Thus, innovative measures are needed for meeting nutrient requirements of livestock from various forages and residues from food crop production. This approach also has the associated advantage of enabling seasonal surpluses for example, cereal straws or silages, to be preserved for use subsequently, when feeds are in short supply such as during the dry seasons and droughts.

## **(3) Increasing The Use Of Dietary Nitrogen Sources**

Associated with the first two strategies is the important need to concurrently increase the use of dietary nitrogen sources, especially non-protein nitrogen (NPN) and also proteinaceous forages. In addition, much more use can also be made of poultry litter which is accessible to most farmers.

Of the methods available for NPN utilisation, the incorporation of urea into cereal straws to release ammonia or spraying of ammonia directly into the cereal straws, and the use of urea-molasses block licks (UMBL) had had considerable success. These two innovations are significant in that they represent two major success stories in Asia.

The value of UMBL is associated mainly with the fact that their attractiveness and taste to livestock. The blocks are a potentially effective means of making NPN such as urea (15-20%) continuously available, fortified with macro and micro minerals and other nutrients, essential to both the microbes and the animal. The possibility of over-ingestion of the block and the danger of toxicity appears to be remote.

Much of the early work in this connection has been confined to buffaloes and cattle in India, the Philippines and Indonesia. Recently however, an attempt has been made to extend the use of UMBL to small ruminants and the three preliminary experiments of Soetanato (1986) in Indonesia are possibly the first of its kind. In experiment 1, the results of digestibility studies with sheep given waffered sugarcane tops (WST) with or without UMBL with 0, 3 or 6% urea and 500g leucaena, indicated that there was an increase in the dry matter disappearance in sacco of waffered sugarcane tops. The results were however not significant. In experiment 2, four growing lambs were placed on each of three treatments : Control (+ 300g fish meal), WST + UMBL (3% urea) and WST + UMBL (6% urea). The results indicated that UMBL stimulated live weight gain which were significant (Table 6). Experiment 3 was similar to that as experiment 2 and used goats instead. However, it was terminated due to ill health of the goats.

These preliminary studies also suggest that the use of UMBL can also be extended to goats, especially in extensive situations where the feeds are coarse and also sparse. This strategy needs to be substantially expanded in terms of future effort.

#### **(4) Strategic Use of Supplementary Protein Sources**

Strategic use of protein supplements also merits some considerations. Its economic use for both goat meat production needs to be carefully considered especially in relation to breed type and the potential for growth. With milk production however, judicious supplementation is necessary ensuring that the value of the milk produced is higher than the cost of the supplements used.

The importance of the decision to supplement is seen in the results of a recent study in India. The treatment involved feeding either green forage, concentrates or green forages + concentrates to a control browsing situation.

Treatments as would be expected, significantly stimulated daily live weight gains and also affected dressing percentages ( $P$  less than 0.05). The net returns indicated that the supplementary feeding with forages gave the highest margin of profits followed by concentrates and finally the combined effect (Table 7). The results emphasise on the one hand the value of green forages, and question the necessity for feeding concentrates for meat production from sheep in this experiment.

The strategy to use scarce concentrates carefully imply that protein concentrates like coconut cake, cottonseed cake, groundnut cake, soyabean meal, palm kernel cake and fish meal, all of which are commonly found can be conserved and preferentially utilised and more efficiently also by non-ruminants animals. Some of these ingredients may even need to be protected for local use rather than be exported.

### CONCLUSIONS

The emphasis on the importance of the feed resources, and the search for efficiency in their utilisation is justified by the fact that their inadequacy represents the main limiting factor to improved performance in goats. This situation, coupled with inefficient feeding systems manifests in consistently low production from goats in developing countries. Correcting this situation merits the highest priority to the management of goats in the future. Dietary nutrient needs must be established which are both qualitatively and quantitatively adequate, involving a balanced energy, protein, mineral and vitamin supply in efficient feeding systems that are consistent with maximum VFI and high performance. These efforts need to be identified with nutritional strategies that can ensure high productivity from the goat genetic resources in the developing countries.

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Category	Availability (10 <sup>6</sup> tonne)
Field Crops	189.9
Tree Crops	4.2
Total	194.1 <sup>+</sup>

<sup>+</sup> Represents 44.9% of the total availability from field and plantation crops.

TABLE 1. THE AVAILABILITY OF NON-CONVENTIONAL FEED RESOURCES IN ASIA AND THE PACIFIC (Devendra, 1985)

Region	Population <sup>++</sup> (10 <sup>6</sup> )	Energy (10 <sup>6</sup> MJ)	Crude Protein (10 <sup>6</sup> kg)
Africa	151.0	1023.8	15.86
N.C. America	14.0	94.9	1.47
S. America	19.8	134.2	2.08
Asia and the Pacific	255.2	1730.3	26.80
Europe	12.5	234.3	4.53
Oceania	0.5	9.4	0.18
USSR	6.5	44.1	0.68
World	459.5	3271.0	51.60
Developed	26.0	504.1	9.76
Developing	432.7	2933.7	45.43

+ The requirements are on a daily basis.

++ From FAO (1984).

TABLE 2. FEED ENERGY AND PROTEIN REQUIREMENTS OF GOATS  
BY REGION<sup>+</sup>

Protein source	Approximate crude protein content	DCP content <sup>+</sup> (%)
1. Banana leaves	18.3	7.4-13.1
2. Casava leaves	22.6	11.5-20.3
3. Cottonseed cake	18.6	11.6-13.0
4. Guar meal	15.2	26.5-38.3
5. Feather meal	88.5	78.6-84.6
6. Leucaena leaves	27.8	13.8-22.9
7. Neem seed cake	15.2	7.2- 8.9
8. Palm kernel cake	19.0	12.8-14.7
9. Palm oil mill effluent	10.6	5.8- 6.6
10. Pigeon pea leaves	26.7	9.1-11.9
11. Poultry litter	24.2	16.6-18.2
12. Rubber seed meal	33.6	18.4-21.7
13. Sal seed meal	9.2	2.4- 3.6
14. Spent tea leaf	32.0	-

<sup>+</sup> For ruminants

TABLE 3. SOME NON-CONVENTIONAL PROTEIN SOURCES AND THEIR APPROXIMATE CRUDE AND DIGESTIBLE CRUDE PROTEIN CONTENTS (% DRY MATTER BASIS)

=====			
Ration <sup>1</sup>			
Item	-----		
	I	II	III
-----			
Characteristic	Corn stover- molasses silage + concentrates	Fresh ipil- ipil leaves + molasses- urea	Fresh ipil- ipil leaves + concentrates
-----			
Number of animals	6	6	6
Number of days on test	150	150	150
Average of weight (kg)	10.47	8.17	10.30
Average final weight (kg)	16.22	15.13	21.63
Average daily gain (kg)	0.04 <sup>a</sup>	0.05 <sup>a</sup>	0.08 <sup>b</sup>
Average daily feed intake (kg)	0.44	0.67	0.68
Average feed efficiency (kg) feed per kg gain	13.89 <sup>a</sup>	14.77 <sup>a</sup>	9.06 <sup>b</sup>
Average dressing percentage	45.97	45.83	46.23
=====			

<sup>ab</sup> Row means having different superscripts are significantly different (P less than 0.05)

<sup>+</sup> Not significant

<sup>1</sup> Roughages were fed ad libitum and concentrate or molasses-urea at 3% of body weight.

Concentrate mixture consisted of coarse rice bran (62%), copra meal (22%), molasses (10%), urea (1%), salt (2.5%) and bone meal (2.5%); Urea comprised 3% by weight of the molasses-urea mixture.

TABLE 4. FEEDLOT PERFORMANCE OF GOATS ON THREE RATIONS IN THE PHILIPPINES (Linggodjiwo, 1976).



Parameter	RS (Control)	RS + 10% L <sup>++</sup>	RS + 20% L	RS + 30% L	RS + 40% L	RS + 50% L	RS + 60% L
Fresh intake, g/day	741.3a	890.7ab	967.7ab	1158.7ab	1446.0bc	1475.7bc	1300.7bc
DMI/kg <sup>0.75</sup> , g/day	59.9a	58.9a	53.2a	59.9a	68.5b	70.7b	59.9a
DMI as, % body weight	2.7a	2.6a	2.6a	2.8a	3.1a	3.1a	2.7a
DM digestibility,	42.4a	48.5b	46.7b	49.5b	50.5b	53.2c	49.6b
OM digestibility,	50.9a	51.3a	49.5a	52.5b	53.3b	55.5b	52.4b
CP digestibility,	19.7a	40.5b	47.2c	49.6c	52.0c	66.2d	50.5c
Energy digestibility,	40.4a	46.4b	46.3b	52.1c	51.5c	54.7c	46.2b
N retention, as % of intake	-0.1a	20.2b	16.4b	23.6b	31.5c	27.5c	30.8c

<sup>++</sup> RS - rice straw, L - leucaena leaves.

abc Means on the same row with different superscripts differ (P less than 0.05).

TABLE 5. INTAKE AND DIGESTIBILITY OF CHOPPED RICE STRAW (RS) SUPPLEMENTED  
WITH VARYING LEVELS OF LEUCAENA LEAVES (Devendra, 1983b)

Diet	DM Intake (g/d)		OM Intake (g/d)		Daily live weight gain (g/day)
	WCT++	UMBL+++	WCT	UMBL	
A <sup>+</sup>	224.94	88.74	186.27	81.07	-35.40
B	236.64	91.81	209.57	83.87	18.57
C	283.27	116.69	234.15	106.47	23.60

<sup>+</sup>A - Natural grass ad lib + 300 g fish meal

B - UMBL + 3% urea

C - UMBL + 6% urea

<sup>++</sup>WCT - Waffered sugarcane tops.

<sup>+++</sup>UMBL - Urea-molasses block licks.

TABLE 6. THE EFFECT OF UREA-MOLASSES BLOCK LICKS SUPPLEMENTATION  
ON FEED INTAKE AND DAILY GAIN OF LAMBS IN INDONESIA (Soetanto, 1986)

Parameter	Browsing (B) <sup>+</sup>	B + forage	B + concentrates	B + forage + concentrates
Initial weight(kg)	12.0	10.9	12.7	12.5
Final weight (kg)	13.8	14.7	22.8	22.3
Weight gain(kg)	1.8	3.7	10.0	9.7
Av. daily gain(g)	19.4	41.7	111.0	108.2
Dressing %	45.7	44.5	48.2	49.1
Net returns (Rs/kid/90 days)	-	9.0	3.6	0.2

<sup>+</sup> For 7 hours daily.

TABLE 7. PERFORMANCE OF WEANER KIDS IN A SEMI-ARID ENVIRONMENT  
IN INDIA (Parthasarathy, Singh and Rawat, 1983)